

## Case Based Learning in The Undergraduate Chemistry Laboratory Using Hplc Analyses of Cbd Products

**Isabella Guerrero**

Our Lady of the Lake University, USA,  <https://orcid.org/0009-0008-4845-186X>

**Charles A Smith**

Our Lady of the Lake University, USA,  <https://orcid.org/0000-0002-5595-1212>

**Abstract:** In case-based learning, students develop and apply course knowledge to solve tangible and “real life” problems. This practice can enhance student motivation and engagement in the analytical laboratory. In this application of case-based learning students analyze commercially available oils for CBD content. In the state of Texas anyone can sell CBD products. Many of these products are advertised as natural alternatives to prescription medications. The products are advertised as natural alternatives to prescription medications and make unfounded claims to treat conditions like chronic pain, depression, anxiety, insomnia, diabetes and psychosis. However, these claims are not recognized by the U.S. Food and Drug Administration and lax labeling and licensing regulations create situations where consumers may not know what CBD content is present in the product. In this online presentation the CBD content in various products will be discussed along with the necessary chemical analysis tools, analytical method, and chemical standards to perform the analysis.

**Keywords:** Science education, Chemistry, HPLC

**Citation:** Guerrero, I. & Smith, C.A. (2023). Case Based Learning in the Undergraduate Chemistry Laboratory Using HPLC Analyses of CBD Products. In M. Koc, O. T. Ozturk & M. L. Ciddi (Eds.), *Proceedings of ICRES 2023-- International Conference on Research in Education and Science* (pp. 2175-2180), Cappadocia, Turkiye. ISTES Organization.

### Introduction

Anyone can sell CBD in Texas. Many of the products are advertised as natural alternatives to prescription medications and make unfounded claims to treat conditions like chronic pain, depression, anxiety, insomnia, diabetes and psychosis. None of these claims are recognized by the U.S. Food and Drug Administration. And because of lax labeling and licensing regulations, unsuspecting consumers may not actually know what they’re buying. Products which contain no more than 0.3% THC can be bought throughout Texas. Any products that are within these guidelines can be sold in Texas. People use CBD or THC products as an alternative to using traditional medications for pain or mental illness.

A cartridge (cart) is something that contains an oil or concentrate that can be attached to an e-cigarette pen. Most carts work with an e-cigarette pen (commonly called vape pens or pens) shown in Figure 1. Powered by a battery which are rechargeable or disposable. The battery powers a heating element which heats the oil into a vapor or aerosol. The aerosol or vapor is then inhaled.



Figure 1. A typical cartridge containing CBD oil

## Method

The HPLC instrument parameters were slightly modified from Storm et al. 2020. With a total run time of 11 minutes, and, column oven temperature of 50C. The mobile phase consisted of solvent A and solvent B. Solvent A consisted of 0.1% Aqueous Phase Formic Acid whereas solvent B consisted of 0.05% Organic Phase Formic Acid. The flow rate: 1 mL/min and all injection volumes were 1  $\mu$ L for standards and 5  $\mu$ L for samples.

Table 1. Mobile Phase gradient composition

Time	% Solvent B
1.5	60
2.5	60
8.5	77
9.7	95

The sample preparation consisted of obtaining 100  $\mu$ L of oil weighed in a 10 mL volumetric flask. After being weighed, 8 mL of ethanol was added to the flask and mixed well. After mixing, ethanol was then filled to 10 mL. 100  $\mu$ L of the solution was then diluted in 900  $\mu$ L HPLC grade methanol and filtered into a glass vial for analysis. Standard preparation consisted of obtaining each standard (1 mg/mL) and mixing in equal amounts and diluted to a concentration of 100  $\mu$ g/mL.



Figure 2. Issues with sample preparation

There were several issues with sample preparation as shown in Figure 2. Carts that were analyzed contained either CBD or  $\Delta$ 8-THC in a concentrated oil. The CBD carts were easy to pipette a sample because the mouthpiece twisted off and the consistency was liquid oil. The  $\Delta$ 8-THC carts could not be pipetted out because the consistency was very sticky and thick. Additionally, the mouthpiece did not screw off, so the cart was broken in the space above the oil.

## Results

The results from the CBD cartridges (carts) and  $\Delta$ 8-THC carts are shown below in Figures 3 through 7. A total of 3 commercial CBD containing carts were analyzed. A total of two  $\Delta$ 8-THC commercially available carts were analyzed.

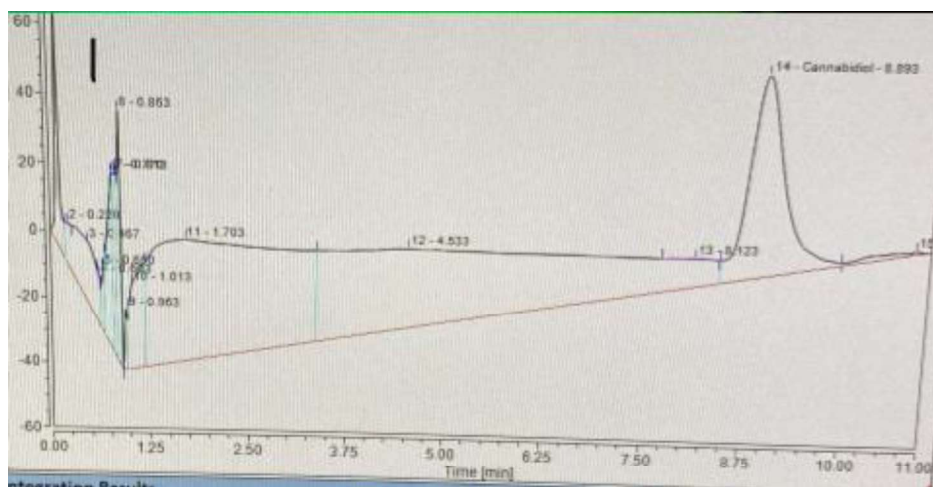


Figure 3. 4.90 mg/mL CBD cart 1

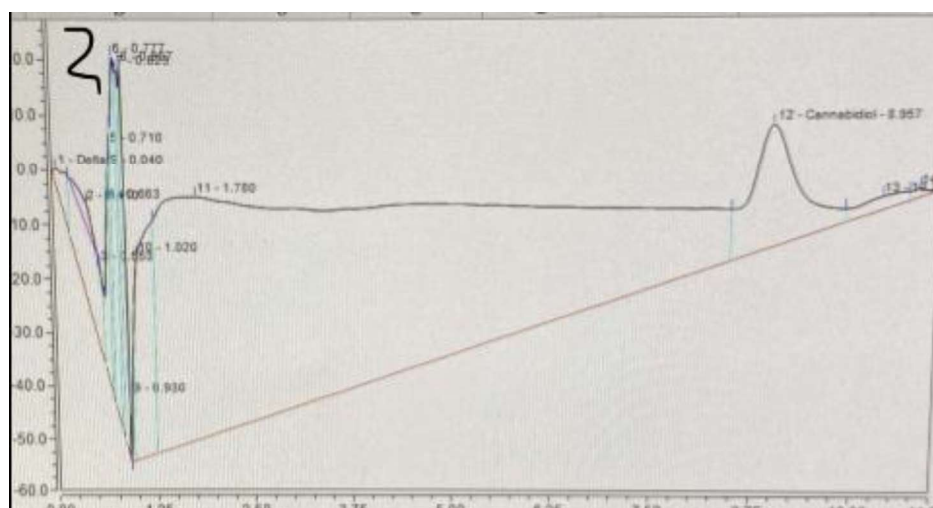


Figure 4. 1.83 mg/mL CBD cart 2

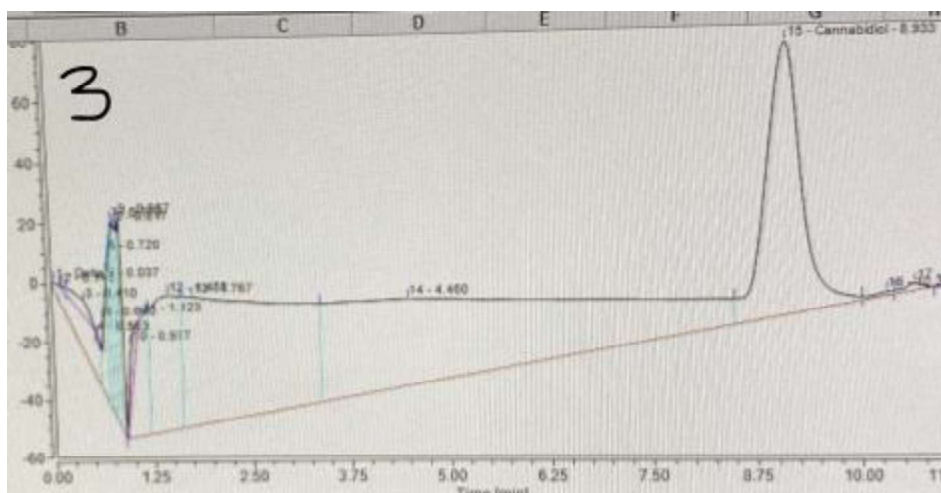


Figure 5. 7.75 mg/mL CBD cart 3

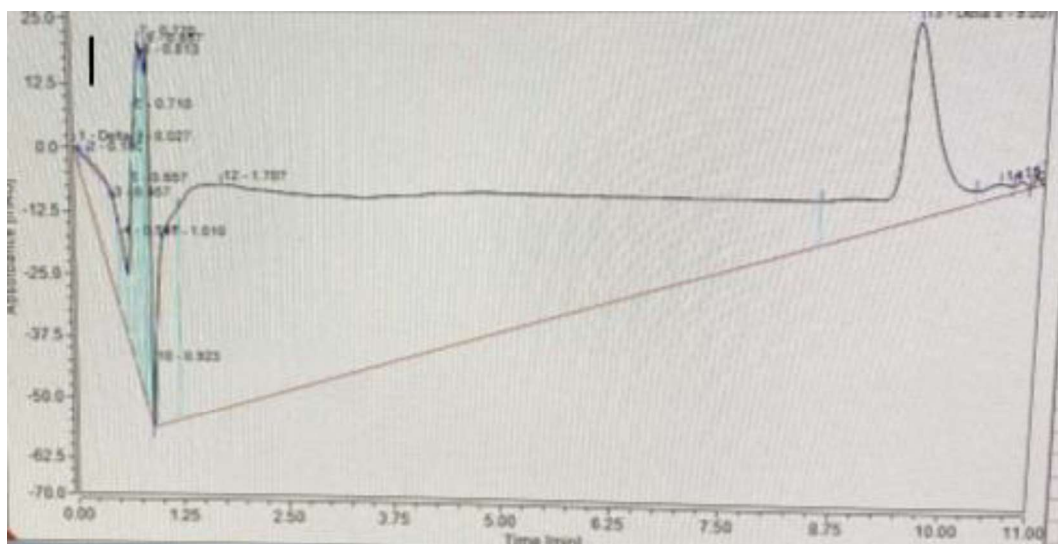


Figure 6. 3.67 mg/mL  $\Delta^8$ -THC cart 1

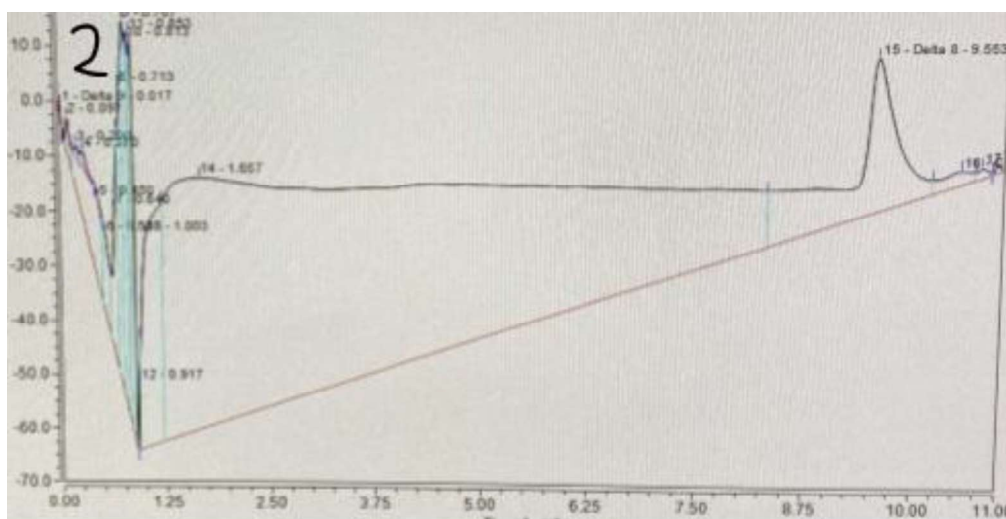


Figure 7. 320 mg/mL  $\Delta^8$ -THC cart 2

## Discussion

It is important to know what is in these CBD/THC products as they become more popular. The results showed that the products tested contained only what they were labelled to contain, so some of these products can be consumed with the knowledge that there are no extra additives. Products must be regulated as they increase in popularity, and future studies should be done to ensure the amounts match the packaging and determine the validity of the claims being made by consumers. Results from this experiment were repeatable and consistent in the undergraduate chemistry laboratory, and the experiment could successfully become a class lab activity. The activity would demonstrate the importance of analytical techniques in monitoring what is in these products and allow students gain experience in the laboratory.

## References

Storm, C., Zumwalt, M., Macherone, A. (2020) "Dedicated Cannabinoid Potency Testing in Cannabis or Hemp Products Using the Agilent 1220 Infinity II LC System", Agilent Technologies Inc., retrieved from <https://www.agilent.com/cs/library/applications/application-dedicated-cannabinoid-potency-testing-5991-9285-en-us-agilent.pdf>